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The Cretaceous transgression in the Dinaric-Hellenic orogen

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In the internal (eastern) part of the Dinaric-Hellenic orogenic system, the units deformed during the earlier tectonic phases (Late Jurassic-Early Cretaceous) are unconformably overlain by the so-called «deposits of the Cretaceous transgression». These latter are made up of terrestrial, transitional and shallow marine coarse clastic sediments and of marine fine clastic and carbonate sediments. The composition of the clastic deposits directly depends on the lithology of the underlying or adjacent substratum.

These sediments presently crop out over areas of varying extension (fig. 1), from several hundreds/thousands of km-wide continuous covers to small-scale slices occurring as tectonic chunks or olistoliths inside tectonic mélanges. These transgressive deposits form a sub-meridian trending stripe in the internal (eastern) part of the orogen, extending from southern Greece (Argolis, BORTOLOTTI *et alii*, 2003) to at least south-western Serbia (BORTOLOTTI *et alii*, 1971; PEJOVIĆ & RADOIČIĆ, 1971; SLADIC-TRIFUNOVIC, 1998; RADOIČIĆ & SCHLAGINTWEIT, 2007), through central and northern Greece, Albania (GAWLICK *et alii*, 2007) and FYROM. Thus, the geodynamic framework in which these deposits developed is presumably that of widespread collapse, involving the orogenic chain after the compressional phase (Late Jurassic-Early Cretaceous).

The substratum of these sediments is formed of (fig. 2):

a) oceanic crust units;
b) oceanic crust units thrusted onto locally metamorphic continental margin units;
c) continental margin units.

The ophiolites show evidences to have been broadly emerged during the compressional phases forming rather high relieves which underwent erosion and pedogenesis, that brought to the development of more or less thick and wide horizons or pockets of alteration deposits, mainly of lateritic composition. In the generally carbonate continental margin units, the peripheral bulge due to the orogenic stress lead to more or less developed emersions and then to the formation of karst depressions.

The subsequent extensional tectonic phase gave origin to horst-and graben structures and there produced an increase of the relief energy, with consequent development of coarse-grained deposits, possibly marine in part, deposited by high-energy rivers. Ophiolite-originated pebbles prevail in proximity of the ophiolitic massifs: above the basal lateritic deposits, the sediment consists of clasts of ophiolitic and radiolaritic rocks and of lateritic duricrusts in usually dark red, argillaceous-lateritic matrix;

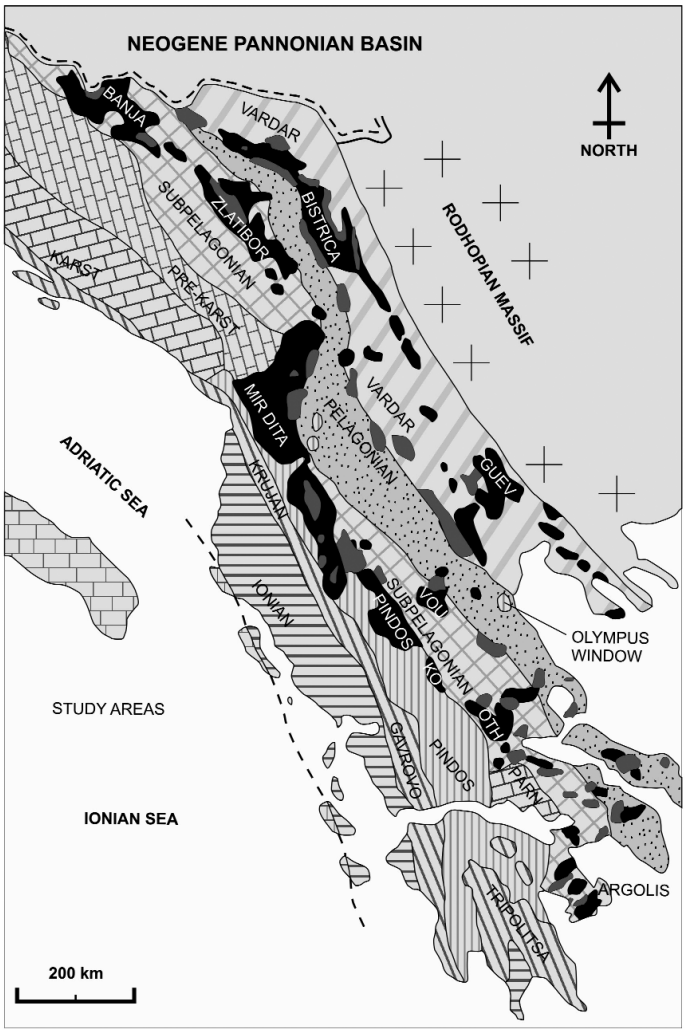

Fig. 1 - Tectonic sketch map of the Dinaric-Hellenic Belt with location of the main ophiolitic massifs (black) and Cretaceous transgressive sequences (dark grey). GUEV: Guevgueli; VOU-Vourinos; KO-Koziakas; OTH-Othrys; PARN-Parnassus Zone. After BORTOLOTTI *et alii*, 2004, modified.
– *Schema tettonico dell'orogene dinarico-ellenico con la localizzazione dei principali corpi ofiolitici (in nero) e delle principali successioni trasgressive cretacee (in grigio scuro). GUEV: Guevgueli; VOU-Vourinos; KO-Koziakas; OTH-Othrys; PARN-Parnasso. Tratto e modificato da* BORTOLOTTI et alii, *2004.*

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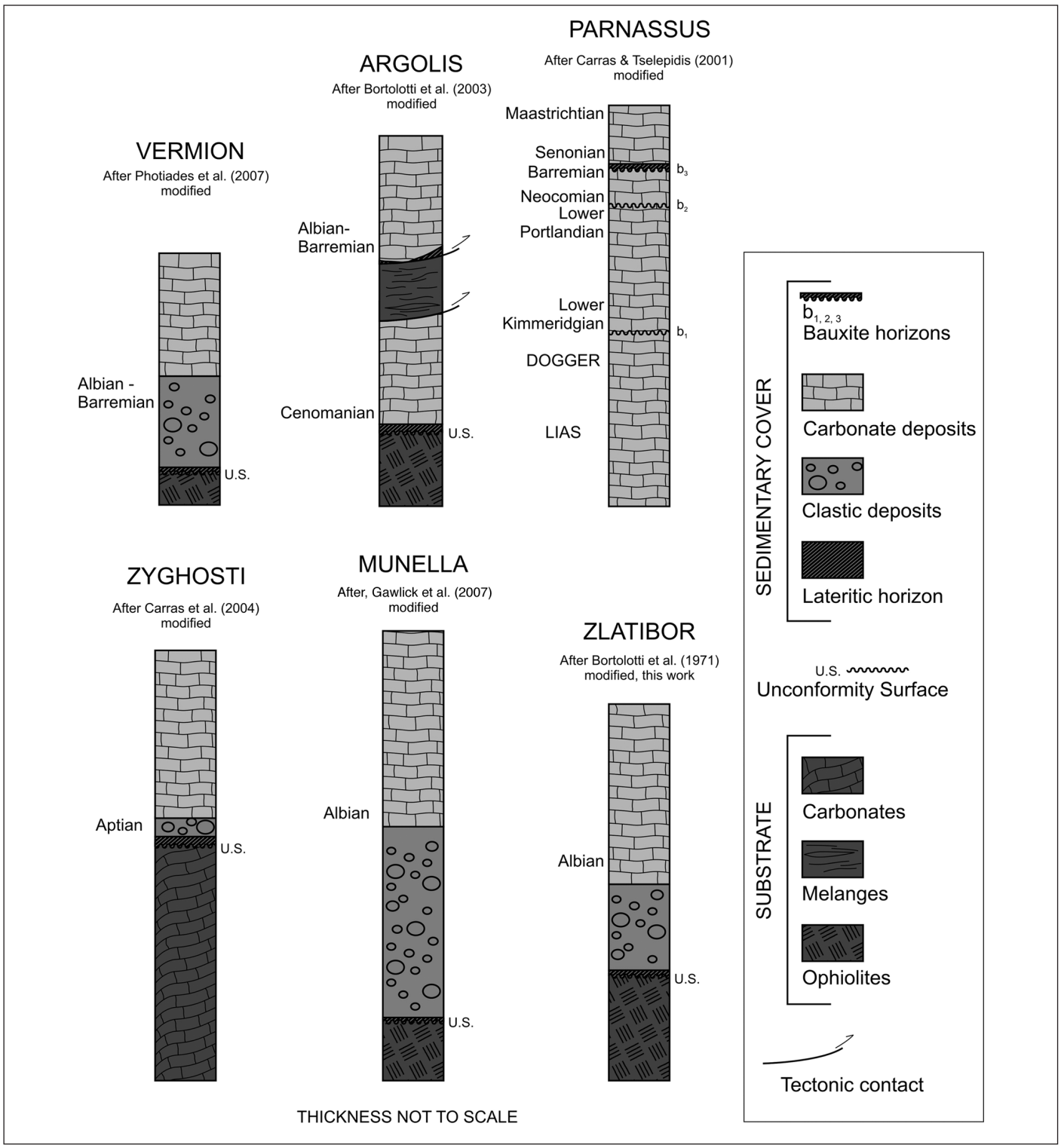

Fig. 2 - Schematic stratigraphic columns of Cretaceous transgressive sequences in the Dinaric-Hellenic Belt.
– Colonne stratigrafiche delle successioni trasgressive cretacee nell'orogene dinarico-ellenico.

continent-derived clasts occur next to the continental margin units onto which the ophiolites were thrusted (e.g. Vermion, PHOTIADES *et alii*, 2007). This sequence generally shows fining-upwards grain size, as the ongoing of erosion causes the relief energy to decrease, even if coarse-grained levels, linked to tectonic pulses may occur. In some cases (e.g. Munella Mountains, Albania) ophiolites are overlain, without the occurrence of lateritic soils in between, by radiolaritic and ophiolitic disorganized debris-flow deposits («wildflysch» or Perlat Formation: GAWLICK *et alii*, 2007), interpreted as filling of foreland basins (Molasse basins). Up to now, the scarcity of published data about the sedimentological features of the coarse grained deposits above the ophiolites in different

regions of the orogen do not allows to sharply establish how widely extended is the occurrence of those syn-orogenic clastic deposits and, where present, if they are also overlain by post-orogenic clastic deposits, before the onset of the shallow-marine carbonate sedimentation. This topic would be the goal of a research at regional scale.

The further sinking of the previously formed wide depressions, often in connection with eustatic rises, lead to the true marine transgression, firstly characterized by carbonate-marly shallow-water deposits, somewhere with build-ups, overlain by deeper-water ramp deposits with tempestites and locally, where the tectonic activity was more influent, by re-sedimented deposits, such as turbidites, debris flows deposits and slumpings. This carbonate sedimentation, referable to still further deeper marine environments, is followed, during early Tertiary by a clastic flysch deposition.

In those areas of the continental margin not thrusted by ophiolites, the relief energy linked to extensional tectonics is generally lower; the first transgressive phase lead to the filling of the karst depressions with lateritic-bauxitic fine-grained materials, originated by the erosion of laterites from surrounding ophiolitic areas. The contiguity of the two areas is demonstrated by the content of ophiolitic-derived ions (Ti, Ni, Cr, etc.) in the lateritic or bauxitic lenses over the carbonates. In some cases, such as those of Parnassus and Zyghosti, the older transgressive deposits over the bauxite and laterite lenses are usually constituted of transitional or shallow-water marine calcareous deposits; at Zyghosti, after the shallow-water sedimentary phase, an intense tectonic collapse originated very thick bodies made up of debris-flows deposits, turbidites and slumps (Carras *et alii*, 2004).

In the Jurassic-Cretaceous carbonate platform of Parnassus three levels of bauxites, interbedded with the limestones, occur within karst depressions that indicate three phases of emersion and karstification (fig. 2). We think that those emersion episodes are linked, possibly by peripheral bulge, with compressional tectonic phases occuring during the orogenesis, and that the bauxitic materials within the karst cavities were originated by supply of weathered materials from nearby ophiolites. Concerning the age of the transgression, it is certainly heterochronous, also over short distances (e.g.: at Zyghosti it varies from early Aptian to late Albian (Carras *et alii*, 2004). Establishing the age of the base is more difficult in those areas where the basal clastic successions are very thick and the determinations are possible only through the fossils in the overlying marine deposits. The oldest fossiliferous deposits are generally Aptian to Cenomanian (Pejović & Radoičić, 1971; Carras & Tselepidis, 2001; Bortolotti *et alii*, 2003; Carras *et alii*, 2004, Gawlick *et alii*, 2007; Photiades *et alii*, 2007; Radoičić & Schlagintweit, 2007). In Albania, Gawlick *et alii* (2007) hypothesize the occurrence during Late Jurassic of a carbonate platform, later on completely destroyed before the onset of the shallow marine deposition during Barremian. In the Parnassus the phases of emersion and karstification occurred during Callovian-Oxfordian, Late Tithonian and Aptian-Turonian.

Starting from the data obtained up to now we can conclude that:

– during Early Cretaceous s.l. a transgressive phase, probably in connection with the extensional tectonics that followed the Late Jurassic-Early Cretaceous compressional phases, set up on the whole Dinaric-Hellenic orogenic belt, extending for more than 2000 Km.

– This transgression seems to be diachronous in different areas.

– The lithologies of the «neo-autochthonous» clastic sediments correspond to those of the local or regional substratum.

– The different lithologies overlying the unconformity surface suggest that there was uniformity of tectonic context, but not of sedimentary environments.

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